Old age pensions, demography and economic growth in the long run: the French case revisited

Reimat, Anne

Old Age Pensions, Demography and Economic Growth in the Long Run: The French Case Revisited

Anne Reimat *

Abstract: *»Altersrenten, Demographie und langfristiges Wirtschaftswachstum: der Fall Frankreich neu besucht«.* This paper analyses the evolution of the French pension system from the mid-nineteenth century to the current period. Competing or complementary hypotheses that can explain the long-run rise in pension expenditure are discussed. The determinants that appear to offer the best explanation for the evolution of pension expenditure are economic growth, the process of industrialization and ageing. The time series related to these determinants are cointegrated over the long run. A multivariate model is estimated in order to assess the long-run elasticities between the pension expenditure and its main determinants.

Keywords: pension system, demography, economic growth, industrialization.

1. Introduction

The objectives of the paper are to analyse the evolution of old age pension expenditure from the middle of the nineteenth century to the current period in France. The French pension system displays singular past and current characteristics (the early importance of public pensions, supremacy of pay-as-you-go funding (PAYG), 'crowding-out' of pension funds, different pension schemes according to workers' status but encompassing coverage) regarding the landscape of pension systems across industrialized countries (Clark 2001; Feller 2005). The particular relationship between the French retirement system, the demography, the economic growth and the process of industrialization can shed light on its historical evolution.

The literature in this area often explains the increase in old age pension expenditure by the evolution of the demography (demographic transition (the 'old age security hypothesis') and population ageing), the process of industrialization (which explains in particular the rise in occupational pension schemes in the most important companies and administrations) and the consequent decline in family support (Cutler and Johnson 2004), the evolution of income and economic growth that improve both the demand for old age security and the

* Anne Reimat, REGARDS, Université de Reims, Rue des Crayères, BP 1035, Reims Cedex 2, France; anne.reimat@univ-reims.fr.

possibility to fund it, the growing role of the state in a more complex economy as early pointed out by Wagner (1892), the market failures regarding pension provision (Barr and Diamond 2006) or the extension of workers' and citizens' rights (the 'social democracy hypothesis', Williamson and Pampel 1993). All these explanations certainly work together to explain the development of pension systems, but the importance of each explanatory variable is generally not specified and the existing empirical analyses often cover a shorter time period.

This paper attempts to assess the role of several explanatory variables in the long-run evolution of the French pension system. The analysis is founded on empirical data on the French retirement system since the middle of the nineteenth century (Reimat 2000, 2001), time series relating to the French economic growth (Toutain 1997; Villa 1994), the process of industrialization (Thélot and Marchand 1991, 1997) and the particular French demography (Chesnais 1986).

Part 2 presents an overview of the French pension system history since the mid-nineteenth century and analyses the evolution of pension expenditures as a share of the GDP. Part 3 establishes a selection of theoretical hypotheses that can explain the old age pension growth over time. In particular, the respective roles of demography, industrialization, economic growth and state intervention are assessed. In part 4, we test and model the long-run relationship between pension expenditure and its determinants, demography, economic growth and spreading of salaried workers among the entire active population. We find that these time series are cointegrated over the long run and we then consider a multivariate model of the long-run relationship between old age pension expenditure and its determinants. Part 5 concludes.

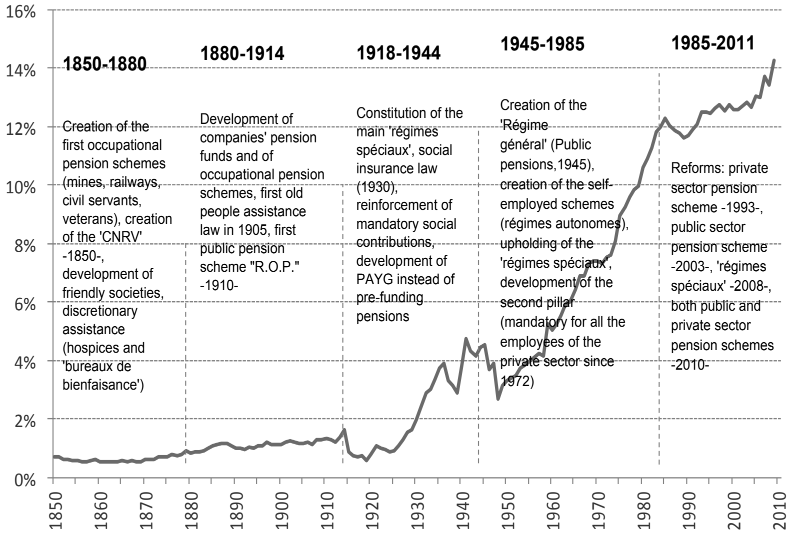
2. The French Pension System in the Long Run: An Overview

The French pension system is gradually implemented from the mid-nineteenth century to the 2000s. Considering pensions as a share of the GDP, and including all kinds of pensions (assistance, occupational schemes, funded and unfunded schemes), five main periods can be distinguished (Figure 1).

From 1850 to 1880, the main public administrations and some large companies began to implement pension schemes for their salaried workers (minors, rail workers), imitating the pension schemes created by the state for its own employees (civil servants, soldiers). These occupational pension schemes provided pensions for old workers as a way to retain workers who still maintained many links with agriculture and who still expected to work only for a limited period as salaried workers, before becoming self-employed in the agricultural sector or the artisanal sector.

A national pension fund was created in 1850 (‘Caisse Nationale des Retraites’) under the supervision of the Caisse des Dépôts et Consignations, to channel the workers’ savings for retirement. The levels of both the interest rate and the savings were guaranteed by the state. In the second part of the nineteenth century, some of the most solid friendly or mutual societies had created a pension fund for their members, although their role in the provision of pensions has remained rather limited, their activity being rather focused on health and other social risks that are easier to cover than retirement. Solidarity towards elderly persons was also ensured by the ‘bureaux de bienfaisance’, assistance offered by local authorities, in order to provide poor people with food and money, or by the ‘hospices’, old age home catering for poor people. However the expenditures devoted to old age remained weak at this stage, estimated at between 0.5 and 0.8% of the GDP during the period (see Figure 1).

Figure 1: Pension Expenditure in the Long Run (% of GDP)



Sources: old age expenditures: (Reimat 2000; 2001; see Table 3 in the Appendix), GDP: Toutain (1997) for 1851-1938, Villa (1994) for 1938-1948, and INSEE after 1948.

From 1880 to the First World War, a first acceleration of old age pensions as a share of the GDP was observed. They began to represent more than 1% of the GDP. Occupational pension schemes continued to extend their cover in several sectors, particularly in the energy and transport sectors. In parallel, saving for retirement was promoted through different measures implemented by the state, both for the ‘Caisse Nationale des Retraites’ and for the mutual societies. The first means-tested assistance law regarding old people was adopted in 1905, called ‘Assistance obligatoire aux vieillards, infirmes et incurables’, aimed at providing an allocation for people aged over 65 with low revenue or ensuring them admission to an old people’s home or poorhouse.

The first attempt to create a public pension scheme was the law entitled ‘Retraites Ouvrières et Paysannes’ adopted in 1910, expected to provide funded pensions to salaried workers aged over 65 years, and after 30 years of contributions. However, the principle of mandatory contributions for both employers and employees was rapidly abandoned, and few workers and employers continued to pay their contributions after 1912 (Feller 2005).

The interwar period is a key period in the development of old age expenditure. Many companies that had previously set up their own pension schemes, particularly in the transport, energy and water supply sectors, already had mature pension funds. When the companies’ schemes were well developed in a sector, they gave birth to the schemes known as French ‘regimes spéciaux’, which allowed their beneficiaries to remain out the private sector’s employee pension scheme. For other salaried workers, the social insurance law was adopted in 1930, but insurance was weak concerning old age pensions, with only 4% contribution rates of wages (half employer and half employee). In the interwar period, the principle of pre-funding pensions became increasingly weakened, and instead pensions began to be paid on a PAYG basis. Both the occupational pension schemes (‘regimes spéciaux’) and the social insurance abandoned the principle of pre-funding contributions to finance the pensions. The post-war inflation had reduced the capital accrued by many pension funds, and companies had no other choice than PAYG to meet their commitments towards their employees. The social insurance law had been expected to finance pensions both on a PAYG and on a pre-funded basis, but the pre-funding part (2% of wages) was abandoned in 1941 in order to provide pensions immediately to elderly people with the current contributions of the workers.

After the Second World War, the growth of pensions as a percentage of the GDP was very important. The pension expenditure as a share of GDP represented 4% in the 1950s, but 12% in the middle of the 1980s. This was really the pension ‘golden age’, even if it was not yet the retirees’ golden age, given the fact that the living standard of old people remained modest.

The French ‘regime general’ was created through the Social Security Act of 1945. It covered all the employees of the private sector. The employees of the ‘regimes spéciaux’ kept their own schemes, which were more advantageous than the newly introduced ‘regime general’. The self-employed obtained the creation of their own pension schemes. So, finally, the entire active population was covered, but under different pension schemes. The second pillar was progressively developed in the biggest companies in order to complete the modest pensions offered by the ‘regime general’. In 1972, a law made the complementary pensions mandatory for all the workers in the private sector. Since then, the scope has been narrowing for the development of occupational pension funds or personal pensions (Figure 2).

Figure 2: French Pension System (Data from 2009)

<table>
<tr><td colspan="4">Funded pension schemes: PERP, Corem, Prefon, Madelin, RMC, PERCO
Pensions in 2009: €6bn (€1bn for individual pensions (PERP and others), €5bn for pension funds).
(Total asset value of funded schemes: €143bn in 2009)
Private, funded</td></tr>
<tr><td>Wage-earners' complementary pension schemes (private sector) (mandatory, points-based)
Pensions: €65.4bn
Contribution rates: 3.8 (employee), 5.7 (employer)
PAYG, Public
(26%)</td><td rowspan="2">Public sector wage-earners' pension scheme

Contributors: 2.3mn
Number of pensions: 1.9mn

Pensions: €40.2bn

Contribution rates: 7.85%* + employer's contribution to balance revenue and expenditures

PAYG, Public

(16%)</td><td rowspan="2">Wage-earners' pension schemes (multiple 'regimes spéciaux')

Contributors: 2.6mn
Number of pensions: 2.0mn

Pensions: €26.9bn

Contribution rates: it depends on the scheme

PAYG, Public

(11%)</td><td>Self-employed complementary pension schemes (mandatory, points-based)
Pensions: €4.4bn
Social contributions based on professional income: depend on the scheme
PAYG, Public

(2%)</td></tr>
<tr><td>Wage-earners' general pension scheme and farm workers (private sector) – first tier (mandatory, annuities)
Number of contributors: 18.3mn
Number of pensions: 14.7mn
Pensions: €96.5bn
Contribution rates: 6.75 (employee), 9.9 (employer)
PAYG, Public
(39%)</td><td>Multiple self-employed pension schemes – first tier (mandatory, annuities)

Contributors: 2.7mn
Number of pensions: 3.9mn

Pensions: €16.2bn

Social contributions based on professional income: 16.65%

PAYG, Public
(6%)</td></tr>
</table>

Note: (*x*%) = % of total mandatory pension. * It will progressively increase up to 10.85%. *Sources:* Commission des Comptes de la Sécurité Sociale and Fédération Française des Sociétés d'Assurance (2011).

From the mid-1980s to the present day, a stage of more moderated growth in pension expenditure has taken place. The old age pension expenditure reached 13-14% of the GDP in the late 2010s. A period of reforms had begun, which will concern all the schemes (private sector, public sector, 'regimes spéciaux'). The objectives of the reforms are to raise the legal retirement age and to increase the qualifying years of social contributions (parametric reforms), but the overall logic of the pension system will remain unchanged.

Figure 2 shows the current architecture of the French pension system, which is characterized by the importance of PAYG and public schemes and by the existence of different pension schemes according to workers' status.

3. How can the Growth of Pension Expenditure in the Long Run be Explained?

The hypotheses that can explain the growth in pension expenditure over time are multiple, competing or complementary. Some authors have put forward political and cultural reasons. The 'social democracy hypothesis' (Lindert 1994; Williamson and Pampel 1993) explains the rise in social spending by the extension of voting rights, the extending power of social democratic parties and unionization[1]. Cutler and Jonhson (2004) and Lindert (1994) found differences in social spending and the adoption of social laws between Catholic and Protestant countries. Nevertheless, we focus here on hypotheses based on economic (industrialization, role of the state, economic growth and market failures) and demographic (demographic transition and ageing) explanations (Barr 1996; Barr and Diamond 2006). Indeed, their role in the growth of pension expenditure in the long term from the middle of the nineteenth century to the current period, appears more direct and measurable and, above all, valid throughout the entire period.

3.1 The Industrialization Hypothesis

The industrial revolution involved major socioeconomic changes, urbanization, an increase in the number of factory workers and salaried workers and a drop in the solidarities within the family. Even though intergenerational cohabitation had never been the norm in France in the nineteenth century, in the agricultural sector it was frequent for a child to be chosen to take care of his old parents (cohabitation or payment of a pension) in exchange for inheriting the familial farm. The French urban population represented 9.1 million persons in the mid-nineteenth century (1851 census), 15 million at the end of the nineteenth centu-

[1] The shortcoming of the 'social democracy hypothesis' as regards our objective to analyse the long-run evolution of a pension system from the mid-nineteenth century until the current period is that these explanations should have worked out their full effect in industrial countries before 1960, or even before 1930 (Lindert 1994).

ry (1896) and 22.7 million at the end of the 1940s[2]. Workers in industry and building represented only 4.4 million in 1851, 6 million in 1896 and 6.4 million in the late 1940s (Thélot and Marchand 1991, 1997).

Beyond the mere workers in industry and building, the progression of salaried workers instead of self-employed workers appears important. Occupational pension schemes as well as the first public pension schemes (Retraites Ouvrières et Paysannes (Workers and Peasants Law) in 1910, Assurances Sociales (Social Insurance) in 1930, Sécurité sociale (Social Security) in 1945) were first implemented for salaried workers only. On the other hand, savings devoted to retirement (Caisse Nationale des Retraites) were used more by self-employed workers, farmers or tradespeople.

These changes tied to the process of industrialization can explain the need for the development of social insurance and welfare programmes. Furthermore, the birth of big companies is the favourite explanation for the appearance of companies' occupational pension schemes during the course of the nineteenth century. By setting up pension arrangements, the companies tried firstly to retain their workforce and secondly to rationalize their management and to find a solution to dismiss the workers who were too old (Hannah 1985, 1986; Kastl and Moore 2010; Sass 1997).

The industrialization thesis gives an explanation for the growth in pension expenditure throughout the nineteenth century and also explains the paradox of the pensions growth in the second part of the interwar period (see Figure 1). Indeed, the trend towards an increase in the number of big companies boosted the creation of occupational pension funds, while the economy suffered from the Great Depression and the low growth rates that followed (Hannah 1986).

However, the industrialization thesis also suffers from weaknesses in explaining the rise in pension expenditure. Old age expenditures pursued its growth even after the decline of the industry after the 1970s, measured by the industrial employment as well as by its share of added value. Additionally, some newly industrialized countries seem reluctant to introduce welfare programmes, so relationships between industrialization and social spending are not automatic and easy to capture[3].

---

2 The urban population is defined as the population of the localities that include at least 2000 inhabitants. This definition was revised in 1962: the population in localities with no more than 2000 inhabitants but located in urban areas is now considered urban.

3 We can add that the institutional arrangements of old age welfare differ markedly among industrialized countries, even at the beginning of the industrialization process. Schematically, in Anglo-Saxon countries, the pension system is more often organized on the basis of private and pre-funded pensions, while it is founded more on PAYG public pensions in continental European countries.

3.2 The Demography Hypotheses

The demography hypotheses explain changes in social expenditure over time by the changes in demography, in particular the growing elderly population.

3.2.1 Demographic Transition

According to the 'old age security hypothesis', parents bear children because they expect their children to care for them in their later years. Such a hypothesis often links the demographic transition to the support of elderly people. It suggests that in the Malthusian stage, children are considered as an asset that allows parents to transfer income to their old age. Higher incomes in this stage increase the fertility rate. In the post-Malthusian stage, technological progress rises and the population growth does not absorb the GDP growth. Higher incomes make it possible to save for retirement and/or begin to invest more in children's education. Investment in education intervenes as the dominating force in the decline of fertility and demographic transition. At this stage, higher incomes are not translated into an increasing fertility rate. The acceleration in the rate of technological process during the second phase of the Industrial Revolution increased the demand for human capital of people's offspring (Galor 2012). Finally, in the modern growth stage, the demographic transition reverses the positive relationship between income and population growth. Fertility rates decrease.

This scenario describes the change from an informal and fertility-related pension system (in which children are responsible for the well-being of their old parents, and therefore future pension benefits are dependent on adult fertility decisions) to a formal pension system (in which the state organizes a mandatory public pension system). Holler (2008) demonstrated that theoretically, the introduction of a mandatory pay-as-you-go public pension system to a country with a previous informal, fertility-related pension system shifts down the inverted U-shaped demand for children connected to income increases. Therefore, lower levels of income support an earlier escape from the first stage of demographic transition (in which income increases lead to increasing fertility). The 'old age security hypothesis' linked to the demographic transition suggests that pension systems can be a major driver for the decrease in fertility rates (Boldrin, De Nardi and Jones 2005).

However, French historical demography provides little support for the 'old age security' thesis. Firstly, the French demographic transition is atypical (Chesnais 1986, 1996; Vallin and Caselli 1999). In the first stage, the mortality decline only shortly preceded the decrease in fertility. In the second stage, the fertility decrease had occurred long before the implementation of old age pensions, so the direction of causality appears inverse to that expected according to the hypothesis: the fertility decrease could not be the result of the implementation of old age pensions. On the other hand, the French low fertility since the nineteenth century could have played a role in the concern for pension system implementation, but if this is the case, it might only be in a marginal way. The birth rate in France was 26.8 per thousand in 1850, but 37.2 in Germany and 33.4 in England (Chesnais 1986, 503). In 1900, the French birth rate was 21.3, but the rate was 35.6 in Germany and 28.7 in England. Beyond the traditional determinants of demographic transition, demographers explain the French low fertility rates as the result of the small size of farms (Chesnais 1986, 324). However, despite its low level of fertility, France does not appear to be a pioneering country in the implementation of a secure pension system.

Secondly, the French baby boom after the Second World War coincided with the 'pension system golden age', in which the spreading of pension benefits among old people was rapid and important and the entire working age population was automatically enrolled in pension schemes including both first and complementary pillars. These demographic facts then appear to contradict the prediction of the old age security hypothesis linking fertility and the pension system.

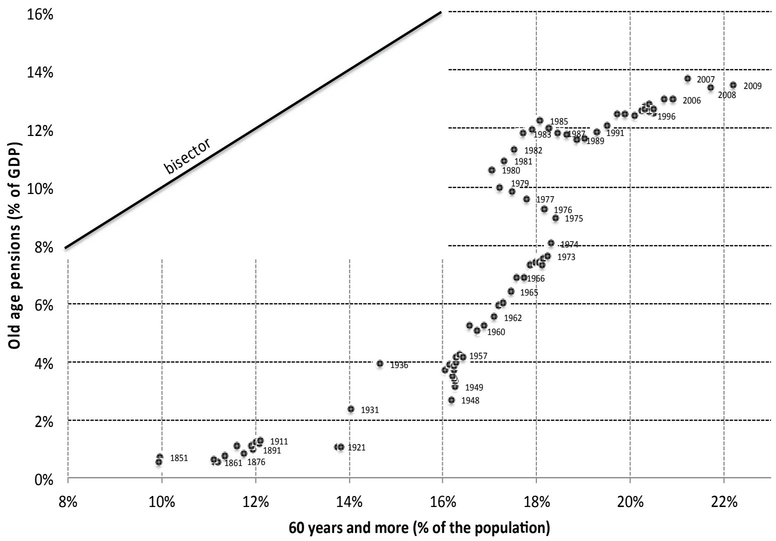
3.2.2 The Role of Ageing

The growth in the number of elderly people over the last centuries is remarkable. The probability of reaching one's sixtieth birthday increased during the nineteenth century, and over the last decades of the twentieth century, gains in life expectancy are also realized at the ages of 60, 70 and 80. Figure 3 displays the relationship between the proportion of elderly people and the share of pensions as a percentage of the GDP. The bisector in Figure 3 indicates the situation in which the share of people aged 60 and over in the population equals the share of old age expenditure in the GDP.

The share of people aged 60 and above represented less than 10% of the whole population in the middle of the nineteenth century, and currently represents more than 22%. In the middle of the nineteenth century, these 10% of elderly people received 0.5% of the GDP in pensions (Figure 3), and nowadays, the 22% of 60 years and over receive more than 13% of the GDP in pensions. The comparison between the proportion of people aged 60 years and more and the pensions as a share of the GDP must be interpreted cautiously, though. Indeed, all the kinds of revenues that a person can gain are not taken into account (revenue from capital, from work, from other social transfers) and there is no equivalence between the population over 60 and the pensioners (some retire before 60 and some retire after 60).

As the share of elderly people in the whole population increases, a reinforcement of pressure towards increased public spending on pensions must be expected. Political science has stressed the role of interest and age groups to explain the evolution of welfare expenditure (Goerres and Vanhuysse 2012). However, this mere explanation cannot rationalize the whole evolution of the pension system or the different institutional configurations of pension systems across nations.

Figure 3: Elderly People and Pension Expenditure



The link between the growth in pension expenditure and the proportion of elderly people appears solid but far from perfect, as we can see from the French data. Some periods are closer to the bisector than others: the 1970-1980 period, characterized by both fewer retirees (due to the First World War drop in fertility) and an improvement in pension levels, is enhanced.

3.3 The Impact of Growth

A major explanation for the growth in pension expenditure over time is based on the income and wealth growth over time.

According to the Engel's well-known law (1857), the greater the income is, the smaller the food share is: and that involves that the consumption can include other goods and services above a certain income level. Old age social insurance, retirement savings, are then considered as 'superior goods', which account for a larger proportion of consumption as income rises. However, the relationship between the growth in pension expenditure and the household revenue is a complex one. Social contributions are often mandatory for workers, even in the companies occupational pension schemes of the nineteenth century. Concerning savings devoted to old age, it seems that their share is increasing according to the income growth, and it is noticeable that the Caisse

Nationale des Retraites and other mechanisms of retirement savings are principally used by high-income households.

The German economist Wagner (1892) has pointed at the end of the nineteenth century a 'law' of expanding state activity linked to higher levels of economic development. The increase in government spending in time is considered to be a result of high income elasticity in the demand for public goods. However, Wagner's law fails to explain why in some wealthy and industrialized countries, public welfare programmes appear later than in the poorest ones (Cutler and Johnson 2004), and why in periods of moderate economic growth or even recession, pension expenditure as well as social spending still rise, playing the role of 'automatic stabilizers'. Furthermore, as pension schemes are mainly public in France (Figure 2), it seems irrelevant to explain the rise in pension expenditures by the rise in public spending, the causality appearing to be rather the reverse.

According to the hypothesis of 'market failures', social insurance and public pensions are the result of the market incapacity to organize spontaneously adequate markets for private pensions and old age insurance. However, this hypothesis should explain only residual old age welfare programmes, and not the importance given to pension systems in most industrialized countries. The theory of 'social insurance', which explains why the insurance must be mandatory in order to bear the risks and face the lack of information between insurers and insured people better (adverse selection and moral hazard), provides a relevant support to the rise in old age social insurance. Nevertheless, this theory cannot explain the different institutional configurations of pension systems observed across industrialized countries: old age social insurance is more developed in European countries with a Bismarckian welfare regime (France, Germany) than in Anglo-Saxon countries (Ireland, the UK).

To sum up, the determinants that are expected to provide a better explanation for the rise in pension expenditures over the long run seem to be ageing, the overall process of industrialization, and the economic growth. These explanations are expected to play a role during the whole long-run period studied and to explain the evolution of the pension system as a whole, not only a component of it.

4. Testing and Modelling the Long-Run Relationship between Pension Expenditure and its Determinants

In this part, we analyse the relationship between the French pension system expenditure, the economic growth, the industrialization process and ageing. We consider a system of variables that comprises the constant pension expenditure, denoted *pt*, the constant GDP, denoted *yt*, the consumer price index, denoted *it*, the number of people aged 60 years and more, denoted *dt*, and the number of salaried workers, denoted *st*.

We call *Xt* the vector of the studied variables.

Xt = (Pt, Yt, It, Dt, St)'

where:

Pt = ln (*pt*)

Yt = ln (*yt*)

It = ln (*it*)

Dt = ln (*dt*)

St = *st/*entire active population

The studied variables, all but those relative to the expanding number of salaried workers (*St*), are expressed in logarithms, to allow for linearization of the geometrical progression inherent in data expressed in levels.

The data cover the 1851-2009 period, thus 159 years. The sources of the data are, for pension expenditure at date *t*, the time series reconstituted by Reimat (2000, 2001), for the GDP at constant prices, the series published by Toutain (1997) for the period 1850-1938 then Villa (1994) for the period 1938-1948 and INSEE[4] after 1949. We also include the consumer price index (sources: Toutain (1997), Villa (1994) and INSEE) in our vector.[5] The population aged 60 years and over is assessed on the basis of the census data (INSEE (1966) before 1950), and the number of salaried workers and the entire active population are found in Thélot and Marchand (1991, 1997) and INSEE after 1990. The number of salaried workers is used as a proxy for an assessment of the role of industrialization, as it can explain the early development of occupational pension schemes in large companies (in the second part of the nineteenth century and the first decades of the twentieth century) and later the development of public pension schemes devoted to salaried workers (both first pillar and complementary pillar).

[4] Recent data from INSEE are available on the French INSEE website.

[5] Johansen's method for cointegration relies on the estimation of the VAR process, which summarizes all the statistical relationships between the considered variables. The VAR is a 'small' macroeconomic model, and the consumer price index, real economic growth and pension expenditure are expected to have relationships (see Appendix, Table 2, Granger causality tests). We adopt here the point of view of Sargent and Sim (1977) and Lucas and Sargent (1978), who suggest the estimation of macroeconomic models without *a priori* ideas about theories (the use of VAR), but with a relevant selection of variables. Another reason is that pensions are never perfectly indexed, or are indexed on past inflation, so part of the evolution of real pension expenditure should remain linked to inflation. Furthermore, some authors suggest relationships between real public spending and inflation (Klein 1985), or between real health expenditure and inflation (Van Elk, Mot and Franses 2010).

4.1 Cointegration of Long-Run Old Age Expenditures, Economic Growth, Ageing and Industrialization Time Series

We analyse firstly the long-run properties of these different time series and their relationships, and therefore their degree of integration and the potential cointegration between the variables.

For each time series, a unit root test (Dickey and Fuller 1979) is applied. For the whole period, the test shows that it was possible to consider each of these variables as integrated processes. In order to assess the number of relationships in this system with five variables, we refer to the procedures drawn up by Johansen (1988) and Johansen and Juselius (1990), who proposed the trace test and the maximal eigenvalue test (λ^{max}).

The Johansen approach to the analysis of cointegration is based upon the vector error correction model (VAR), as shown below:

$$\Delta X_t = \sum_{i=1}^{k-1} \Gamma_i \, \Delta X_{t-i} + \Pi \, Z_{t-k} + C + V_t$$

where *Xt* is a vector of variables (*Pt*, *Yt*, *It*, *Dt*, *St*) that are integrated processes and Γi and Π are coefficient matrices.

The search for cointegration between the variables is undertaken via the eigenvalues of the long-run coefficient matrix Π using maximal eigenvalue and trace tests (Table 1 and Table 2).

Table 1: Trace Test Statistics

		Critical values		
H0: Rank ≤ *x*	Test statistic	90	95	99
0	94.06	65.82	69.82	77.82
1	39.41	44.49	47.85	54.68
2	18.56	27.07	29.80	35.46
3	6.94	13.43	15.49	19.93
4	0.998	2.71	3.84	6.63

The test is issued from an unconstrained VAR model with a vector of constants C.

The statistics value of the trace test associated with the rank ≤4, ≤3, ≤2, ≤1 hypotheses are respectively against the H0 hypothesis, equal to 0.998, 6.94, 18.56, 39.41. Then, more than one cointegration relationship should not exit. Concerning the rank=0 test, the trace statistic attains a value of 94.1, which is superior to the quintile at 90, at 95 and at 99 of its asymptotical distribution under the H0 hypothesis.

The maximal eigenvalue (λ^{max}) test confirms these results (see Table 2). We can then conclude to the existence of a unique cointegration relationship among the five studied variables.

This cointegration relationship applies in the long run, for more than a century and a half, between pension expenditure, economic growth, ageing, the evolution of salaried workers among the active population and the consumer price index. This makes consistent both the choice of the variables and the multivariate modelling analysis that follows.[6]

Table 2: Maximum Eigenvalue Test Statistics

		Critical values		
H0: rank ≤ *x*	Test statistic	90	95	99
0	54.65	31.24	33.88	39.37
1	20.86	25.12	27.59	32.72
2	11.62	18.89	21.13	25.87
3	5.94	12.30	14.26	18.52
4	1	2.71	3.84	6.63

4.2 Modelling the Long-Run Relationship

In parallel, the above results support the formulation of a long-term relationship between the five variables via a multivariate equation (Engle and Granger 1987, 1991). This will allow us, in particular, to appreciate the pension expenditures long-run responses as regards the studied variables through the estimation of elasticity coefficients. However, this cannot be achieved using the cointegrated coefficients resulting from Johansen's methodology. Indeed, cointegrated systems must be interpreted cautiously (Lütkepohl 1993, 379). Cointegrated coefficients ignore all the other relations between the variables that are summarized in a VAR model.

We then estimate the long-term elasticities between pension expenditure (*Pt*) and economic growth, ageing and the spreading of salaried workers through a multivariate equation.[7]

6 Tests for Granger-causality in the cointegrated system showed that the probabilities of non-causality between ageing and pension expenditure, growth and pension expenditure, and the spreading of salaried workers and pension expenditure are low (see Appendix, Table 2).

7 The least square (LS) estimation method ignores the cointegration restriction and estimates the process in levels of the original variables without taking differences. Indeed, Park and Phillips (1989) and Sims, Stock and Watson (1990) have shown that the unconstrained LS estimator has the same asymptotic properties as the maximum likelihood estimator that observes the cointegration restriction. An additional result is that the usual estimator of the covariance matrix is a consistent estimator of the asymptotic covariance matrix (Lütkepohl 1993, 369). This property allows us to consider the student test as relevant.

We estimate the equation as follows:

$$\underset{(t\ student)}{P_t} = \underset{(13.0)}{1{,}1\ Y_t} + \underset{(3.4)}{0{,}8\ D_t} + \underset{(10.1)}{0{,}2\ I_t} + \underset{(3.6)}{0{,}02\ S_{t-12}} - \underset{(13.9)}{0{,}6\ Indic_{1915-1930}}$$

$$+ \underset{(9.4)}{0{,}4\ Indic_{1927-1946}} - \underset{(3.3)}{12{,}0} + \epsilon_t$$

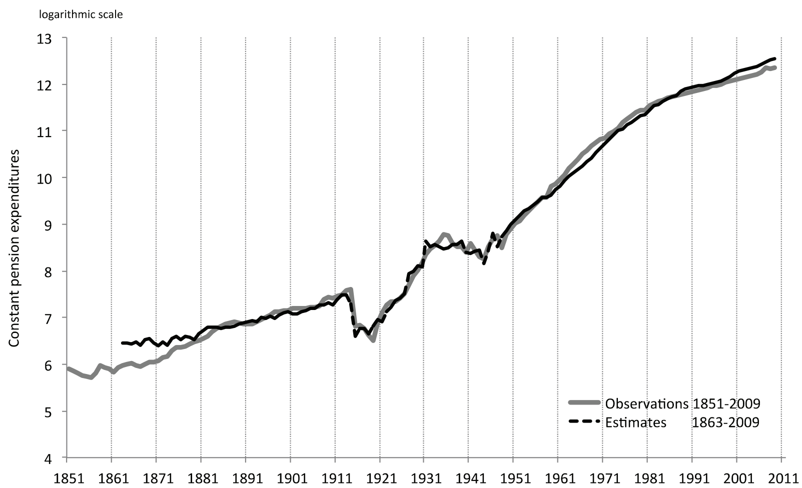
$R^2 = 99.5\%$

where $Indic_{1915\text{-}1930}$ equals 1 on the 1915-1930 period and 0 otherwise, and $Indic_{1927\text{-}1946}$ equals 1 on the 1927-1946 period and 0 otherwise.

These indicator variables allow for the historical particularity of the interwar period to be taken into account (see Figure 1).

The spreading of the salaried workers among the active population is integrated with 12 years of delay, computed in order to maximize the student *t*. At the same time, it is relevant to introduce a lag between the spreading of salaried workers among the active population, and the implementation of pension schemes for aged workers.

Figure 4: Long-Run Pension Expenditure Modelling



The results of the estimation are plotted in Figure 4. As the equation is built on the logarithms of the variables, it allows for an interpretation of the coefficients as elasticity coefficients.

Thus, during a century and a half, growth of 1% of constant GDP involves growth of 1.1% of the pension expenditure, growth of 1% of people aged 60 years and more entails growth of 0.8% of the pension expenditure, and a 100 point increase in the proportion of salaried workers among the active population raises the pension expenditure by 0.02% and prices also have a positive effect on pension expenditure.

In short, it appears quite consistent that pension expenditures presents an elasticity of order one to the GDP and to ageing. The pension expenditure has been affected in the long run by economic growth, demography and the increase in the number of salaried workers.

5. Concluding Remarks

The present study has analysed the evolution of the French pension system in the long run – over more than 150 years. Pension expenditure represented less than 0.5% of the French GDP in the mid-nineteenth century, and currently represents 13.5% of the GDP (2010). Pension expenditure includes all the pension schemes (occupational pension schemes, funded pensions, public pension schemes and old age assistance). Several hypotheses were put forward and discussed to explain this long-run evolution, and permitted us to select a number of variables – industrialization, economic growth and ageing – that we might expect to be strongly related to pension expenditure.

We found that the GDP, consumer price index, spreading of salaried workers among the active population, ageing and pension expenditure are significantly cointegrated in the long term. Economic growth, the process of industrialization and ageing explain a great part of the increase in pension expenditure. The estimation of a multivariate model allowed us to assess the effects (elasticity) of these determinants on the pension expenditure's evolution.

The analysis implemented here for the French pension system should be enriched later by further interesting developments. In particular, three improvements can be suggested. Firstly, even if long-run cointegration is established, a statistical analysis that distinguishes several periods of time should allow the measurement of the importance of each determinant during different periods. Indeed, the test for cointegration assumes that the relationship is constant during the studied period. Yet, the long-run relationship between the underlying variables can change, especially during the long time period considered.

Secondly, despite the overall reliable fit founded between the variables, perhaps the introduction of other determinants discussed in part 3 but not included in the test for cointegration and the modelling, and perhaps different ones for each period, should also improve the knowledge relating to pension expenditure's trends.

Thirdly, it will be interesting to conduct a long-term comparative analysis of pension systems, and verify whether the same determinants can explain the long-run evolution of pension expenditures in other countries. However, this implies the availability of long-run time series for at least a century, which severely reduces the number of countries that can be selected for such a comparison. Following the same idea of improving the knowledge of pension systems through comparative analysis, it should be useful to consider not only the pension expenditure as a whole, but several components of the pension expenditure (old age assistance, first pillar, second pillar…) and their determinants.

This long-term comparison should be particularly interesting, as the French pension system model is considered quite singular in comparative analyses. The importance of pay-as-you-go pensions, mandatory social contributions, the second pillar that encompasses all private sector workers, the quasi-absence of funded pensions, and pensions as a share of GDP, which distinguishes the French model, are indeed the legacy of a long history.

Appendix

Table 3: Pension expenditures as a percentage of GDP, 1850-2009 (source: Reimat 2000, 2001)

Year	Pension expenditures (% of GDP)	Year	Pension expenditures (% of GDP)	Year	Pension expenditures (% of GDP)	Year	Pension expenditures (% of GDP)
1850	0.72%	1890	1.00%	1930	1.97%	1970	7.41%
1851	0.72%	1891	0.99%	1931	2.39%	1971	7.33%
1852	0.64%	1892	0.99%	1932	2.88%	1972	7.54%
1853	0.65%	1893	1.06%	1933	3.03%	1973	7.63%
1854	0.58%	1894	1.02%	1934	3.35%	1974	8.06%
1855	0.58%	1895	1.10%	1935	3.74%	1975	8.95%
1856	0.54%	1896	1.11%	1936	3.92%	1976	9.24%
1857	0.55%	1897	1.22%	1937	3.32%	1977	9.60%
1858	0.60%	1898	1.15%	1938	3.17%	1978	9.86%
1859	0.63%	1899	1.12%	1939	2.92%	1979	9.99%
1860	0.56%	1900	1.13%	1940	3.77%	1980	10.61%
1861	0.55%	1901	1.23%	1941	4.74%	1981	10.90%
1862	0.54%	1902	1.24%	1942	4.32%	1982	11.28%
1863	0.55%	1903	1.21%	1943	4.16%	1983	11.83%
1864	0.55%	1904	1.19%	1944	4.46%	1984	11.99%
1865	0.59%	1905	1.18%	1945	4.55%	1985	12.28%
1866	0.55%	1906	1.20%	1946	3.71%	1986	12.01%
1867	0.58%	1907	1.14%	1947	3.91%	1987	11.86%
1868	0.54%	1908	1.32%	1948	2.70%	1988	11.79%
1869	0.56%	1909	1.32%	1949	3.14%	1989	11.61%
1870	0.61%	1910	1.36%	1950	3.31%	1990	11.68%
1871	0.65%	1911	1.29%	1951	3.41%	1991	11.90%
1872	0.63%	1912	1.24%	1952	3.50%	1992	12.09%
1873	0.71%	1913	1.37%	1953	3.73%	1993	12.48%
1874	0.70%	1914	1.66%	1954	3.86%	1994	12.50%

Table 3 continued...							
1875	0.72%	1915	0.89%	1955	4.00%	1995	12.45%
1876	0.79%	1916	0.77%	1956	4.14%	1996	12.61%
1877	0.76%	1917	0.73%	1957	4.23%	1997	12.74%
1878	0.81%	1918	0.74%	1958	4.18%	1998	12.55%
1879	0.91%	1919	0.60%	1959	5.24%	1999	12.76%
1880	0.85%	1920	0.80%	1960	5.05%	2000	12.60%
1881	0.87%	1921	1.09%	1961	5.26%	2001	12.57%
1882	0.88%	1922	1.00%	1962	5.54%	2002	12.69%
1883	0.94%	1923	0.98%	1963	5.93%	2003	12.85%
1884	1.02%	1924	0.88%	1964	6.01%	2004	12.68%
1885	1.10%	1925	0.94%	1965	6.42%	2005	13.04%
1886	1.13%	1926	1.08%	1966	6.88%	2006	13.01%
1887	1.16%	1927	1.31%	1967	6.90%	2007	13.72%
1888	1.16%	1928	1.54%	1968	7.33%	2008	13.43%
1889	1.10%	1929	1.64%	1969	7.42%	2009	13.50%

Table 4: Granger Causality Tests

Null Hypothesis	Obs	F-Statistic	Prob.
Yt does not Granger Cause *Pt* *Pt* does not Granger Cause *Yt*	158	0.69619 3.68489	0.4053 0.0567
Dt does not Granger Cause *Pt* *Pt* does not Granger Cause *Dt*	158	3.55958 0.12412	0.0611 0.7251
It does not Granger Cause *Pt* *Pt* does not Granger Cause *It*	158	13.5870 3.21022	0.0003 0.0751
St does not Granger Cause *Pt* *Pt* does not Granger Cause *St*	158	0.66859 4.15717	0.4148 0.0432
Dt does not Granger Cause *Yt* *Yt* does not Granger Cause *Dt*	158	5.91391 0.25010	0.0162 0.6177
It does not Granger Cause *Yt* *Dt* does not Granger Cause *Pt*	158	16.9416 25.7592	6.E-05 1.E-06
St does not Granger Cause *Yt* *Yt* does not Granger Cause *St*	158	2.53426 4.19422	0.1134 0.0422
It does not Granger Cause *Dt* *Dt* does not Granger Cause *It*	158	4.09579 0.20698	0.0447 0.6498
St does not Granger Cause *Dt* *Dt* does not Granger Cause *St*	158	8.14406 7.41109	0.0049 0.0072
St does not Granger Cause *It* *It* does not Granger Cause *St*	158	0.11798 3.17021	0.7317 0.0770

Sample: 1851 2009
Lags: 1

References

André, Christine, and Robert Delorme. 1983. *L'Etat et l'économie: un essai d'explication de l'évolution des dépenses publiques en France (1870-1980)*. coll. Economie et société, Paris: Ed. Du Seuil.

André, Christine, Robert Delorme and Guy Terny. 1973. Les dépenses publiques françaises depuis un siècle. *Economie et statistique* 43: 3-14.

Barr, Nicholas. 1996. Economic Theory and the Welfare State: A Survey and Interpretation, London. *Journal of Economic Literature XXX*: 741-803.
Barr, Nicholas, and Peter Diamond. 2006. The Economics of Pensions. *Oxford Review of Economic Policy* 22: 15-38.
Boldrin, Michele, Mariacristina De Nardi, and Larry E. Jones. 2004. Fertility and Social Security. NBER Working Paper 11146.
Chesnais, Jean-Claude. 1986. *La transition démographique. Etapes, formes, implications économiques. Etudes de séries temporelles (1720-1984) relatives à 67 pays.* Paris: Presses Universitaires de France.
Chesnais, Jean-Claude. 1992. *The Demographic Transition: Stages, Patterns, and Economic Implications.* Oxford: Clarendon Press.
Clark, Gordon L. 2001. Requiem for a National Ideal? Social Solidarity, the Crisis of French Social Security, and the Role of Global Financial Markets. *Environment and Planning A* 33 (11): 2003-24.
Cutler, David M., and Richard Johnson. 2004. The Birth and Growth of the Social-Insurance State: Explaining Old-Age and Medical Insurance Across Countries. *Public Choice* 120 (1/2) 07: 87-121.
Dickey, David A., and Wayne A. Fuller. 1979. Distribution of the Estimators for Autoregressive Time Series with a Unit Root. *Journal of the American Statistical Association* 74: 427-31.
Diebolt, Claude, and Anne Reimat. 1997. Old Age Policies in France and Germany from the Last Decades of the Nineteenth Century to the First World War. A Quantitative Re-definition. *Historical Social Research* 22 (3/4): 181-97.
Engel, Ernst. 1857. Die Produktions- und Consumtionsverhältnisse des Königreichs Sachsen. *Zeitschrift des Statistichen Büreaus des Königlich, Sächsischen Ministeriums des Innern* 8: 1-54.
Engle, Robert F., and Clive W.J. Granger. 1987. Co-integration and Error-Correction: Representation, Estimation and Testing. *Econometrica* 55: 251-76.
Engle, Robert F., and Clive W.J. Granger. 1991. *Long-Run Economic Relationships. Readings in Cointegration*. Oxford: Oxford University Press.
Feller, Elise. 2005. Retirement in France in the Early Twentieth Century: From Suspicion to the 'French Model'. *Proceedings of the Western Society for French History* 33: 325-39.
Galor, Oded. 2011. *Unified Growth Theory*. Princeton: Princeton University Press.
Galor, Oded. 2012. The Demographic Transition: Causes and Consequences. *Cliometrica* 6: 1-28.
Goerres, Achim, and Peter Vanhuysse, eds. 2012. *Ageing Population in Post-Industrial Democracies: Comparative Studies of Policies and Politics*. Abingdon: Routledge.
Hannah, Leslie. 1985. Why Employer-Based Pension Plans? The Case of Britain. *The Journal of Economic History* 45 (2): 347-54.
Hannah, Leslie. 1986. *Inventing Retirement: The Development of Occupational Pensions in Britain*. Cambridge: Cambridge University Press.
Holler, Johannes. 2008. On the Role of Pension Systems in Economic Development and Demographic Transition. Department of Economics, University of Vienna, Working Paper 0812.
INSEE. 1966. *Annuaire Statistique de la France, résumé rétrospectif.* Paris: Imprimerie nationale.

Johansen, Soren. 1988. Statistical Analysis of Cointegration Vectors. *Journal of Economic Dynamics and Control* 12: 231-54.

Johansen, Soren, and Katarina Juselius. 1990. Maximum Likelihood Estimation and Inference on Cointegration – With Applications to the Demand for Money. *Oxford Bulletin of Economics and Statistics* 52: 169-210.

Kastl, Jakub, and Lyndon Moore. 2010. Wily Welfare Capitalist: Werner von Siemens and the Pension Plan. *Cliometrica* 4: 321-48.

Klein, Rudolf. 1985. Public Expenditures in an Inflationary World. In *The Politics of Inflation and Economic Stagnation,* ed. Leon N. Lindberg and Charles S. Maier, 196-223. Washington: The Brooking Institution.

Lindert, Peter H. 1994. The Rise of Social Spending, 1880-1930. *Explorations in Economic History* 31: 1-37.

Lucas, Robert E., and Thomas J. Sargent. 1979. After Keynesian Macroeconomics. *Federal Reserve Bank of Minneapolis, Quarterly Review* 2: 1-16.

Lütkepohl, Helmut. 1993. *Introduction to Multiple Time Series Analysis*. Berlin: Springer-Verlag.

Park, Joon Y., and Peter C. B. Phillips. 1989. Statistical Inference in Regressions with Integrated Processes: Part 2. *Econometric Theory* 5: 95-131.

Reimat, Anne. 1997. *Les retraites et l'économie. Une mise en perspective historique, XIXe-XXe siècles*. coll. Logiques économiques, Paris: L'Harmattan.

Reimat, Anne. 2000. Assistance et prévoyance – Histoire quantitative de la prise en charge de la vieillesse en France, XIXe-XXe siècles. *Economies et Sociétés série AF* 27: 7-114.

Reimat, Anne. 2001. Les régimes de retraites – Histoire quantitative de la prise en charge de la vieillesse en France, XIXe-XXe siècles. *Economies et Sociétés série AF* 28: 1097-193.

Sargent, Thomas, and Christopher A. Sims. 1977. Business Cycle Modeling Without Pretending To Have Too Much A Priori Economic Theory. Federal Reserve Bank of Minneapolis Working Paper 55.

Sass, Steven. 1997. *The Promise of Private Pensions: The First Hundred Years*. Harvard: Harvard University Press.

Sims, Christopher A., James H. Stock and Mark W. Watson. 1990. Inference in Linear Time Series Models with Some Unit Roots. *Econometrica* 58: 113-44.

Stock, James H., and Mark W. Watson. 1988. Testing for Common Trends. *Journal of American Statistical Association*: 1097-1107.

Thélot, Claude, and Olivier Marchand. 1991. Deux siècles de travail en France. INSEE Etudes.

Thélot, Claude, and Olivier Marchand. 1997. *Le travail en France 1800-2000*. coll. Essais & Recherches, Paris: Nathan.

Toutain, Jean-Claude. 1997. La croissance française, 1789-1990: nouvelles estimations. *Economies et Société*s 31 (11): 5-136.

Vallin, Jacques, and Graziella Caselli. 1999. Quand l'Angleterre rattrapait la France. *Population & Sociétés*: 346.

Van Elk, Roel, Esther Mot, and Philip H. Franses. 2010. Modeling Health Care Expenditures: Overview of the Literature and Evidence from a Panel Time Series Model. *Expert Review of Pharmacoeconomics & Outcomes Research* (1): 25-35.

Villa, Pierre. 1994. Un siècle de données macroéconomiques. *Insee Résultats*: 86-7.

Wagner, Adolph. 1892. *Grundlegung der Politischen Ökonomie*. Part 1, vol. 1, 3rd ed. Leipzig: Winter.
Williamson, John B., and Fred C. Pampel. 1993. *Old-Age Security in Comparative Perspective*. New York: Oxford University Press.